ORIGINAL ARTICLE

Physical activity level and exercise in patients with diabetes mellitus

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Summary

Objective: To compare physical activity level (PAL) and care related to exercise in patients with diabetes mellitus (DM). **Methods:** DM outpatients (adult, insulin-user patients) were assessed for PAL (international questionnaire; moderate- and high-level activities, as well as walking, over a typical week) and questioned about formal exercise practice, self-care, and hypoglycemic episodes related to exercise or reasons for not exercising. **Results:** Two hundred twenty five patients were assessed: 107 (47.6%) had type 2 diabetes mellitus (DM2) and 118 (52.4%) had type 1 diabetes mellitus (DM1), with a larger percentage of patients with DM2 being classified as poorly active [33 (30.7%) *versus* 12 (10.3%)] and a lower percentage being classified as highly active [9 (8.7%) *versus* 29 (25%)], compared with patients having DM1. Patients who do not exercise (n = 140) gave different reasons for not doing so: patients with DM2 claimed that they "felt uncomfortable", "presented medical restrictions", and "did not like it"; DM1 patients claimed that they "had no time to exercise", "were lazy", and "had hypoglycemic episodes". Only 85 patients exercised regularly, regardless of the PAL, and 38.8% performed self-care, such as eating, stretching, and capillary glucose monitoring. Patients with DM2 [5 (14.3%)] reported a lower number of hypoglycemic episodes related to exercise than those with DM1 [17 (34%)]. **Conclusion:** Patients with DM2 have different PAL and behavior related to exercise than those seen in DM1 patients.

Keywords: Diabetes mellitus; hypoglycemia; self-care; exercise.

INTRODUCTION

Diabetes mellitus (DM) is a syndrome constituting a public health problem due to its high prevalence, morbidity, mortality, and treatment cost[1]. It is estimated that the number of individuals with DM worldwide will be 42% higher by 2030[1]. In Brazil, DM total prevalence is 7.6% and, out of this population, 46% are not aware of the diagnosis[2]. At least 150 minutes of physical activity at a moderate level every week are recommended for patients with DM[3]. In a systematic review followed by a meta-analysis, recently published, 150-minute weekly aerobic exercise for less than 12 weeks was found to reduce glycated hemoglobin (HbA1c) by 0.5% (95% CI –0.79; -0.23%) in patients with DM[4]. However, a limitation to exercise is a higher number of hypoglycemic episodes reported[5]. Therefore, recommendations regarding food intake, self-monitoring and insulin dose adjustment should be individually made and always considered when exercise is prescribed or indicated to a patient with DM[6].

In a telephone call survey (VIGITEL Study) across the 26 Brazilian state capitals and the Federal District, the self-reported inactivity prevalence during leisure time was 60% for 54,369 Brazilian subjects[7]. This elevated inactivity prevalence is no different in subjects with altered blood glucose or diabetes[8], despite the higher risk of cardiovascular death in patients with DM2 compared with the general population[9].

Thus, knowing the DM patients' physical activity level (PAL) would allow, in the clinical practice, the formulation of strategies to encourage exercising with directions for self-care measures to reduce hypoglycemic episodes. Additionally, patients with DM1 and DM2 are believed to have distinct characteristics and needs regarding physical activity. The objective of the present study was to compare PAL and care related to exercise among patients with DM1 and DM2.

METHODS

STUDY DESIGN AND PATIENTS

This was a cross-sectional study on patients with DM1 and DM2 consecutively attended to at the Diabetes Outpatient Clinic of the Department of Endocrinology at the Hospital de Clínicas de Porto Alegre (HCPA) from July 2008 to August 2009. The following summarized World Health Organization criteria were used to diagnose DM1: diagnosis of DM before the age of 30, with insulin use being required within the first year of diagnosis and/or diabetic ketoacidosis presence or a trend to ketosis. DM2 diagnosis was established as follows: patients were > 30 years of age at DM onset, with no prior ketoacidosis episodes; and insulin users initiating the medication only 5 years after DM diagnosis[10]. Only patients > 18 years of age who regularly used insulin were included. After to sign the informed consent, eligible patients responded to the international PAL assessment questionnaire, addressing self-care and hypoglycemia while exercising. Clinical, anthropometric,

and laboratory features were collected from the patients' medical records concerning a visit to the attending physician concomitantly to the questionnaire administration. The current protocol was approved by the Ethics and Research Committee of the HCPA.

PROCEDURES

For the evaluation of the PAL, the International Physical Activity Questionnaire (IPAQ) was used in its extended version, with 27 self-administered questions in five sections: physical activity (PA) at work, PA as a mode of transport, PA at home (as housework and family care), PA as leisure (games, sports, exercise), and time spent sitting (on a typical week day and weekend). Patients were classified as low physical activity, moderate physical activity, and high physical activity, which was estimated from the daily energy expenditure in metabolic units[11]. Regular exercising (frequency, type of activity, and time spent exercising) was also surveyed. Among patients reporting they exercised, an open question about performing any kind of specific care (before, during or after the exercise) was asked, aiming to assess their understanding regarding self-care recommendations related to exercise[12]. Questions about whether the insulin dose should be changed, about having a snack before or after physical activity, and about symptoms possibly related to hypoglycemia were also asked. For those patients reporting they did not exercise, the reasons for not exercising were asked.

Anthropometric measures used to assess the nutritional status were weight (Filizola™ anthropometric scale) and height (fixed stadiometer), with the patient wearing light clothes and no shoes. The body mass index $[(BMI) = weight (kg) / height^2 (m^2)]$ was used to rate the nutritional status according to criteria established by the WHO[13]. Ethnicity (white and non-white subjects), education (years of education), and current smoking were self-reported. The drinking report was based on the number of doses (14 g of ethanol) per day, week or month, and divided as weekly doses.

In the laboratory studies, the following tests were available from the patients' medical records: fasting blood glucose (colorimetric enzyme method), HbA1c (high performance liquid chromatography, Tosoh 2.2 Plus HbA1c device; Tosoh Corporation – Tokyo, Japan; reference range: 4.8-6.0%), total cholesterol and serum triacylglycerols by a colorimetric-enzyme method (Modular P; Roche Diagnostics – Basel, Switzerland); HDL-cholesterol by the direct homogeneous method (autoanalyzer, ADVIA 1650), and LDL-cholesterol estimated by the Friedewald's formula (LDL-cholesterol = total cholesterol – HDL-cholesterol – triacylglycerols/5) when triacylglycerols < 400 mg/dL[14]. Measurements were made at the Department of Clinical Pathology of the HCPA.

Statistical analysis

The variable symmetry was tested by Kolmogorov-Smirnov. The results are expressed as mean ± standard deviation (SD), median (interquartile range), or as the number of patients with the analyzed characteristic in each group (%) according to the variable type (continuous or categorical) and its symmetry. For a comparison between the two patients' groups (DM1 *versus* DM2), Student's *t*-test, the Mann-Whitney U-test, the Chi-square test, or Fisher's exact test were used, as indicated.

A model of multiple logistic regression was designed to assess a potential association between each self-care aspect related to exercise (capillary glucose monitoring, eating, and insulin dose adjustment) and hypoglycemia reports (dependent variable). P-values < 0,05 were considered statistically significant (SPSS 16.0; SSS Inc. Chicago, IL).

Results

Two hundred twenty-five patients with DM were assessed, with 107 patients having DM1 (47.6%), and 118 having DM2 (52.4%). Demographic, clinical, anthropometric, lifestyle, and laboratory characteristics of the patients, according to DM type (DM1 *versus* DM2) are shown in Table 1. Differences in age, BMI, height, education, proportion of white subjects, alcohol consumption (wine and beer), fasting blood glucose, HDL-cholesterol and triacylglycerols values were observed both in patients with DM2 and in patients with DM1. Sixty-five patients (55.1%) with DM2 and 58 patients (54.2%) with DM1 reported consulting with a nutritionist, with no difference between the groups (p = 0.865).

PAL and regular exercising

PAL, as defined by the IPAQ questionnaire, which considers the frequency and duration of walking activity and performance of moderate and brisk activities in a typical week, was assessed, and the patients' distribution according to the proposed rating is shown in Figure 1. A larger percentage of low active patients and a lower percentage of highly active patients were observed in DM2 group compared with DM1 group (p < 0.001). While comparing the PAL rating with the exercise report, 6 out of 51 patients (11.8%) rated as low active by IPAQ reported regular exercising, and 18 out of 40 patients (45%) rated as very active reported they did not exercise regularly (p < 0.001).

Table 1 – Demographic, clinical, anthropometric, lifestyle, and laboratory characteristics of patients according to diabetes type (n = 225)

	Patients with DM1	Patients with DM2	p
n	107	118	–
Male	51.0 (47.7%)	43.0 (36.4%)	0.088[1]
Age (years)	37 ± 11	62 ± 11	< 0.001[2]
White	95.0 (88.8%)	90.0 (76.3%)	0.013[1]
DM duration (years)	17 ± 9	17 ± 9	0.522[2]
BMI (kg/m^2)	24.8 ± 4.0	30.2 ± 5.3	< 0.001[2]
Height (cm)	166.0 ± 9.4	159.9 ± 15.9	0.001[2]
Education (years)	10 ± 3	6 ± 4	< 0.001[2]
Current smoking	13.0 (12.1%)	13.0 (11%)	0.581[1]
Drinking	29.0 (27.1%)	17.0 (14.5%)	0.020[1]
Number of drinks per week	1.0 (0.5-2.0)	1.0 (0.5-1.6)	0.629[3]
Fasting blood glucose (mg/dL)	205 ± 105	163 ± 65	< 0.001[2]
HbA$_{1c}$ (%)	9.2 ± 2.2	9.2 ± 1.9	0.911[2]
Total cholesterol (mg/dL)	183 ± 41	175 ± 45	0.208[2]
HDL-cholesterol (mg/dL)	60 ± 16	48 ± 16	< 0.001[2]
LDL-cholesterol (mg/dL)	102 ± 33	94 ± 39	0.118[2]
Triacylglycerols (mg/dL)	81 (58-117)	143 (105-117)	< 0.001[3]

Data are presented as mean ± SD, median (interquartile range), or number of cases to total of patients ratio in each group (%).
HbA1c = glycated hemoglobin (reference range = 4.8 – 6.0%). [1]Chi-squared; [2]Student's t-test; [3]Mann-Whitney U-test.
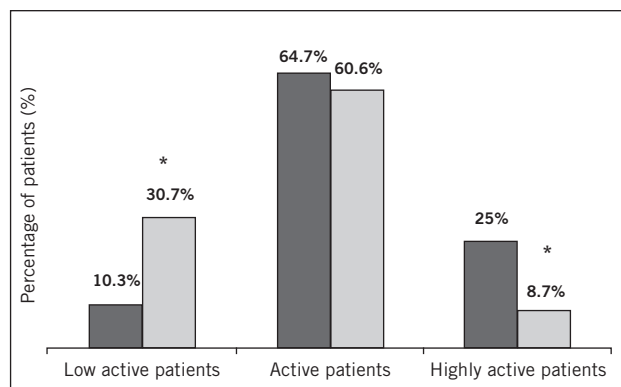
Figure 1 – DM1 (dark gray; n = 107) and DM2 (light gray; n = 118) patient distribution, according to the physical activity level (IPAQ 2009); *p < 0.001 (Chi-squared test).

PATIENTS' REPORTED REASONS NOT TO EXERCISE REGULARLY

One hundred forty patients from both DM groups reported they did not exercise regularly for different reasons. Figure 2 shows the distribution of patients according to the reported reasons for not exercising: DM2 patients "felt uncomfortable", "had medical restrictions", "did not like it", whereas DM1 patients "had no time", "were lazy", and "had hypoglycemic episodes" (p < 0.001).
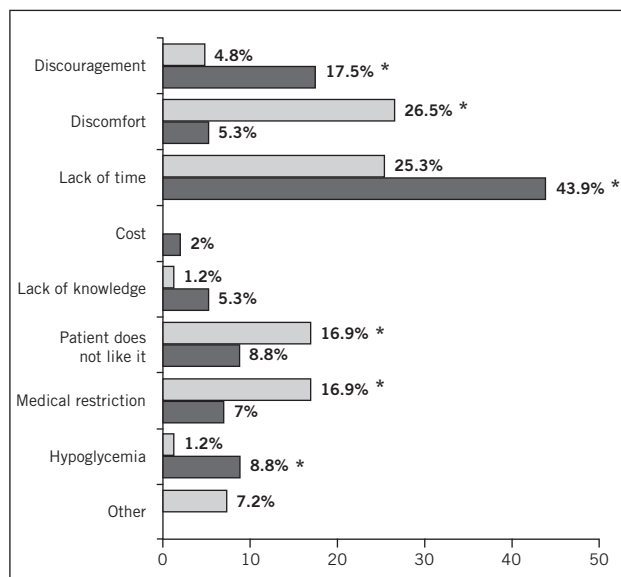

Figure 2 – Percentage of reports on the reason for not exercising. DM2 (light grey; n = 83) *versus* DM1 (dark grey; n = 57) patients; *p < 0.001 (Chi-squared test).

REGULARLY EXERCISING PATIENTS AND EXERCISING-RELATED SPECIFIC CARE

From a total of 225 patients with DM, only 85 patients (37.1%) reported they exercised regularly, regardless of the PAL rating they achieved in IPAQ. Table 2 shows the

characteristics of time and type of exercise, and the care related to regular exercise. A lower percentage of patients with DM2 (29.7%) reported exercising regularly compared with the DM1 group (46.7%); p = 0.008. Only five patients with DM1 reported strength training, with one of them reporting the concomitant practice of aerobic exercises.

Among the 85 patients reporting regular exercises, 33 (38.8%) reported some kind of self-care while exercising: "eating" was reported by 40%, followed by "stretching" for 27.3%, "stretching associated with warm-up" (9%), "capillary glucose monitoring" (9%), and "glucose monitoring associated with feeding" (9%). Only two patients (6%) reported "capillary glucose monitoring associated with stretching". Hypoglycemic symptoms reported by the patients were: "sweating", "tremor", "confusion", "disorientation", "weakness", and "malaise". Table 2 shows other measures adopted while exercising.

Table 3 shows the results of multiple regression analysis for factors associated with exercise-related hypoglycemic episodes. Independent variables were chosen based on univariate analysis results and previously known biological relevance. No association between self-care measures while exercising and exercise-related hypoglycemia was found.

DISCUSSION

Patients with DM2 have different PALs and behavior related to exercises compared with DM1 patients: a higher percentage of low active individuals, a lower percentage of highly active individuals and regularly exercising individuals, as well as lower reports of exercise-related hypoglycemic events. The reasons for not exercising regularly are also different for both groups. However, regardless the type of DM, only one-third of patients reported regular exercising and, out of these, only 33 patients (38.8%) adopted some kind of special care, with only 10% adjusting the insulin dosage.

DM2 patients were observed to exercise less compared with DM1 group. However, studies in the literature comparing PAL and different types of diabetes, especially using IPAQ, were not found. This fact makes it difficult to appropriately compare the results found in the present study. The results can be partly explained by the populations' characteristics. Patients with DM2 were older, had higher BMI, and lower education compared with the DM1 group. Additionally, PAL rating by the tool used (IPAQ) also considers physical activity at work and leisure time as contributing to physical activity. Individuals with DM1 are younger and, therefore, more active at work and leisure time.

Of note, the reasons for diabetic patients not exercising and the questioning of exercise-related self-care knowledge are poorly described in the literature. Only

Table 2 – Exercise and self-care characteristics in patients reporting regular exercise

	Type 1 DM	Type 2 DM	p
n	50	35	–
Regular exercise	50 (46.7%)	35 (29.7%)	0.008[1]
Exercise time (min/week)	199 ± 142	171 ± 105	0.335[2]
Aerobic training	45 (90%)	35 (100%)	0.156[1]
Self-care before, during, and after exercise	19 (38%)	14 (40%)	0.852[1]
Snack associated with exercise	30 (60%)	32 (91.4%)	0.150[1]
Insulin dose adjustment	7 (14%)	2 (6%)	0.221[1]
Capillary glucose monitoring	7 (14%)	0 (0%)	0.038[1]
Exercise-related hypoglycemia	17 (34%)	5 (14.3%)	0.041[1]

Data are presented as mean ± SD, median (interquartile range) or number of cases to total of patients ratio in each group (%).
[1]Chi-squared; [2]Student t test.

Table 3 – Logistic regression model with a dependent variable "report of hypoglycemic episodes while exercising". (n = 85)

Variável	RC	IC 95%	p
No change in insulin dose during exercise (raw)	2.58	0.625-10.634	0.190
No change in adjusted insulin dose during exercise[1]	1.94	0.428-8.836	0.389
No change in adjusted insulin dose during exercise[2]	2.2	0.463-10.163	0.326
No snack associated with exercise	1.36	0.436-4.240	0.596
No snack associated with exercise[1]	2.14	0.613-7.510	0.232
No snack associated with exercise[2]	2.00	0.551-7.251	0.293
No capillary glucose monitoring before, during, or after exercise	4.44	0.909-21.727	0.065
No capillary glucose monitoring before, during, or after exercise[1]	4.52	0.709-28.770	0.111
No capillary glucose monitoring before, during, or after exercise[2]	4.37	0.674-28.368	0.120

[1]Model 1, adjusted for DM type, BMI, exercise time per week, training type (aerobic or resistance).
[2]Model 2, adjusted for variables in model 1 + two other exercise-related self-care measures.

two cross-sectional studies describe the reasons for not exercising reported by patients with DM2[10,15]. Among the 225 patients in the present study, 62% of them reported that they did not regularly exercise. The most frequent reasons were they "had no time", "felt uncomfortable", "had medical restrictions", being similar to those found by other authors[10,15].

One-third of the 225 patients evaluated in the present study reported regular exercise, regardless of the daily PAL rating. The prevalence of regular exercising in patients with DM in Brazil is quite broad, ranging from 23% to 57%[16,17]. However, PAL in the studies reviewed[8,10,16,18] was rated using different assessment tools, which limits a more accurate comparison. Otherwise, regular exercise, as one of the components in managing DM[12], is not often

adopted by the majority of the DM population. In an interventional study to promote regular exercising guided by a licensed physical trainer, a 65% adherence was observed in a small sample of patients with DM (80% with DM2), mainly due to family support, as well as specialized guidance and return of test results (HbA1c control) to patients after exercising periods[15].

A recent study assessed aerobic and resistance training effects in patients with DM2[19]. The combination of strength and aerobic training, interspersed over different days of the week, showed a greater reduction in HbA1c levels and use of antidiabetic drugs [OR = 2.9 (95% CI = 1.2-7.0)], compared with the control group [OR = 1.5 (95% CI = 0.6-3.8)]. In addition, in recent meta-analysis of random trials in patients with DM2, an improved blood

glucose control, measured by HbA1c in patients performing resistance training [−0.57 (−1.14 to −0.01); p < 0.001], aerobic training [−0.73 (−1.06 to −0.40); p < 0.001], or combining both [−0.51 (−0.79 to −0.23); p < 0.001] for over 150 minutes weekly, was shown[4]. Only encouragement to exercise has not shown to be so beneficial [−0.58 (−0.74 to −0.43); p < 0.001], however, when associated with dietary recommendations [−0.16 (−0.50 to 0.18); p < 0.001][4], an additional reduction in HbA1c levels was observed.

Among the 85 patients reporting regular exercise, 39% of them reported adopting some kind of special care. When questioned specifically about having a snack associated with exercising, 76.5% of the patients responded "yes", showing that many patients were not aware of the snack as a special care measure while exercising. Prospective case studies suggest hypoglycemia prevention (assessed by HbA1c, severe hypoglycemia episodes, or capillary glucose values) could be based upon education regarding self-care in patients with DM1[20,21]. In fact, the present results suggest that capillary glucose self-monitoring may be the most important factor in preventing exercise-related hypoglycemia episodes.

Recently, a self-care assessment questionnaire in patients with DM was validated in Brazil[22]. Failure to adjust dosage may be associated with a higher frequency of hypoglycemia episodes in patients who regularly exercise. However, in the present study, the insulin dose adjustment or a snack did not prevent hypoglycemia occurrence.

In this setting, a lower percentage of patients with DM2 (14.3%) reported exercising-related hypoglycemia episodes, compared with the DM1 group (34%). Causes for hypoglycemia in patients with DM2 may be related to hypoglycemia history, aggressive treatment with insulin, sleep, kidney failure, and may be more frequent at the onset of regular exercising[23].

Only half of patients assessed in the present study reported consulting with a nutritionist and, out of those, only 60% reported adherence to the prescribed diet, and most of them were given general instruction about exercising by a physician or a nutritionist. Thus, the introduction of a licensed physical trainer into the healthcare team would allow for an individualized exercise prescription, which would be planned according to the needs, goals, fitness level, and patient history, further enhancing the exercise's beneficial effects[24,25], raising adherence and reducing complications resulting from poor training.

Since diabetic patients have different PAL and behavior regarding exercise, their individualization, through the use of a tool such as IPAQ, would: 1) allow for the acknowledgement of their PAL; 2) sensitize and educate the low active patients about the importance of exercise; 3) sensitize and educate the active patients about the appropriate management of regular exercise. When physical exercise is considered, its type, duration, intensity, and goal should be assessed in order to obtain the best outcomes with the lowest rates of hypoglycemia. Yet it should be noted that patients with DM1 and DM2 have different needs, which should be considered when PA is encouraged as a part of diabetes management. Capillary glucose self-monitoring should always be encouraged, especially in patients exercising and using insulin.

Random trials to evaluate the effect of educational intervention on raising PAL and self-care measures during exercise are required to strengthen the findings of the present study.

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